INTERNATIONAL ORGANISATION FOR STANDARDISATION
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ISO/IEC JTC 1/SC 29/WG 4 MPEG VIDEO CODING

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Title	**[GSC][JEE 6.3-related] Efficiency of temporal smoothing of all non-positional attributes in video-based GSC**
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1. Abstract

This document presents the results of an approach similar to the one presented in M73422, allowing for temporal averaging of not only the opacity attribute but all the non-positional attributes for stationary splats.

2. Proposed method (description from M73422 with modifications)

Let GOP contain N frames and S splats per frame. For each splat index s:

2.1. Displacement measurement

Compute per-axis extremes over the GOP:

$$\Delta X_s = \max_{f=1..N} X_{f,s} - \min_{f=1..N} X_{f,s}$$

$$\Delta Y_s = \max_{f=1..N} Y_{f,s} - \min_{f=1..N} Y_{f,s}$$

$$\Delta Z_s = \max_{f=1..N} Z_{f,s} - \min_{f=1..N} Z_{f,s}$$

Normalize by global ranges $R_i = AttrMaxGOP_i - AttrMinGOP_i$, then compute total displacement ratio:

$$R_s = \frac{\Delta X_s}{R_X} + \frac{\Delta Y_s}{R_Y} + \frac{\Delta Z_s}{R_Z}$$

2.2. Static splat selection

If $R_s \leq T$ where T is a threshold (e.g., 0.001) splat s is classified as static, otherwise dynamic.

2.3. ~~Opacity~~ Non-positional attributes smoothing

For each static splat s, compute the mean ~~opacity~~ value of each attribute except for positions:

$$\overline{a_s} = \frac{1}{N} \sum_{f=1}^{N} \alpha_{f,s}$$

3. Experimental results

The algorithm has been implemented in MPEG GSC TMCV. It required implementing three major steps:

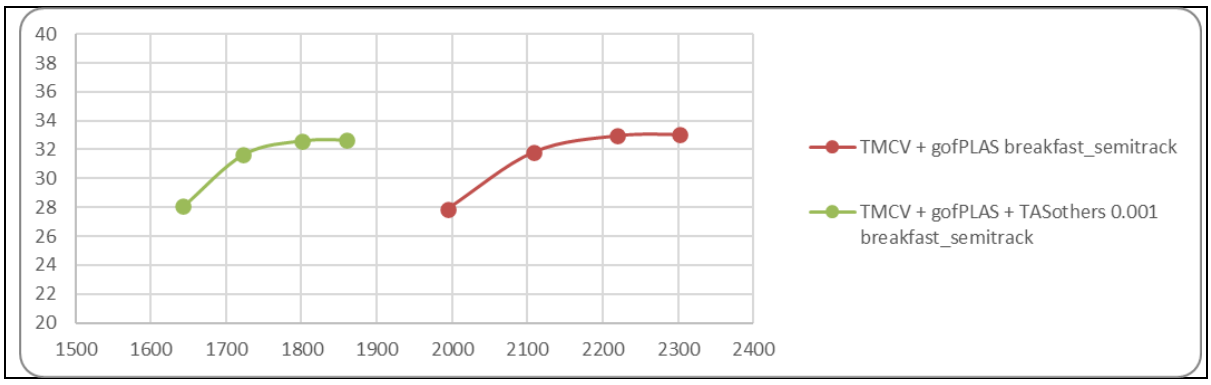
1. Preserving the sorting order from 0^{th} frame for all remaining frames within a GOP,
2. Analysis of splat staticness over entire GOP,
3. Temporal averaging of attributes for static splats.

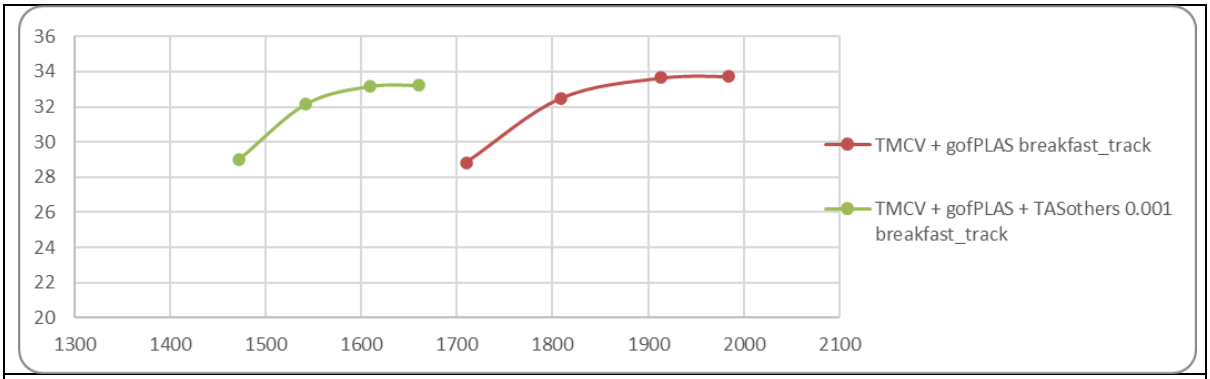
The proposed algorithm has been tested under CTC for GSC, with three different staticness threshold of 0.001 and 0.0002:

0.001:

Anchor	**TMCV + gofPLAS**
Proposal	**TMCV + gofPLAS + TASothers 0.001**

Sequence	BD-rate RGB-PSNR	BD-rate YUV-PSNR	BD-rate YUV-SSIM
breakfast_untrack	#ARG!	#ARG!	#ARG!
breakfast_semitrack	-17,8%	-17,8%	-18,0%
breakfast_track	-13,9%	-13,9%	-14,2%
cinema_semitrack	-0,8%	-0,8%	-0,8%
cinema_track	#ARG!	#ARG!	#ARG!
bartender_semitrack	-0,2%	-0,3%	-0,3%
bartender_track	-9,2%	-9,2%	-9,1%

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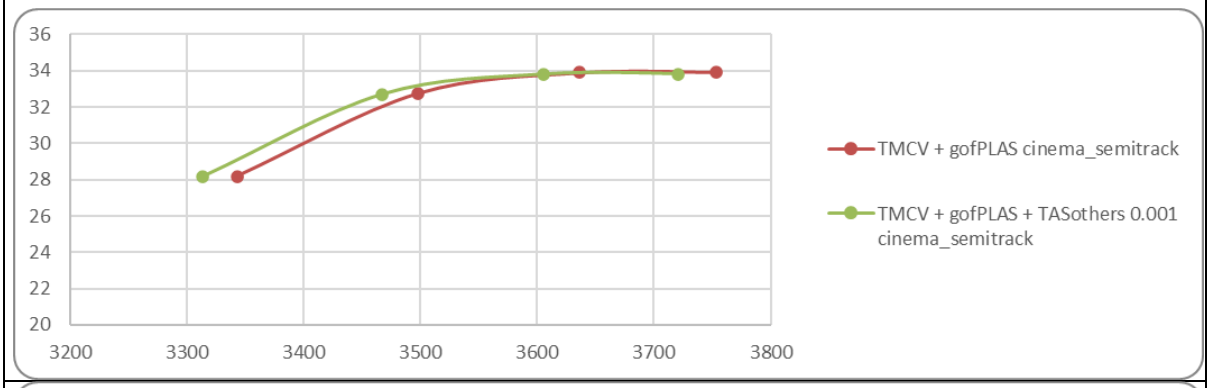
TMCV + gofPLAS breakfast_track
TMCV + gofPLAS + TASothers 0.001 breakfast_track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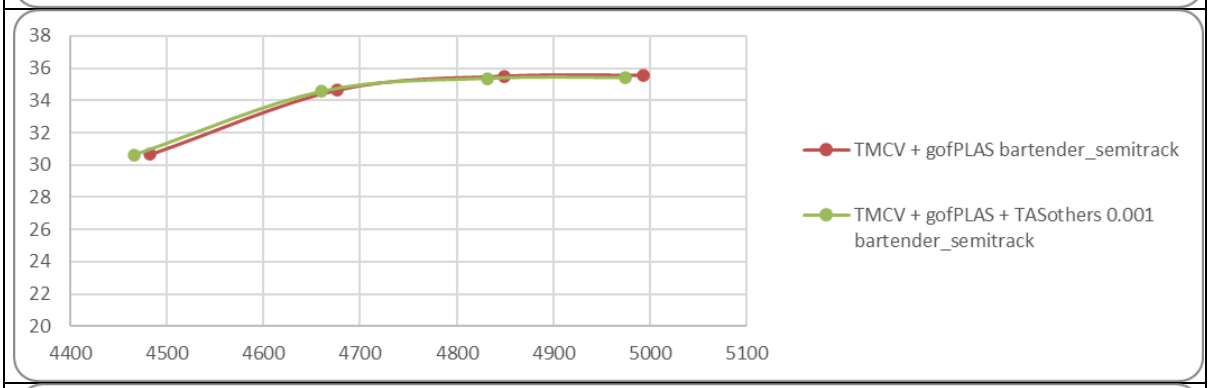
TMCV + gofPLAS + TASothers 0.001 cinema_semitrack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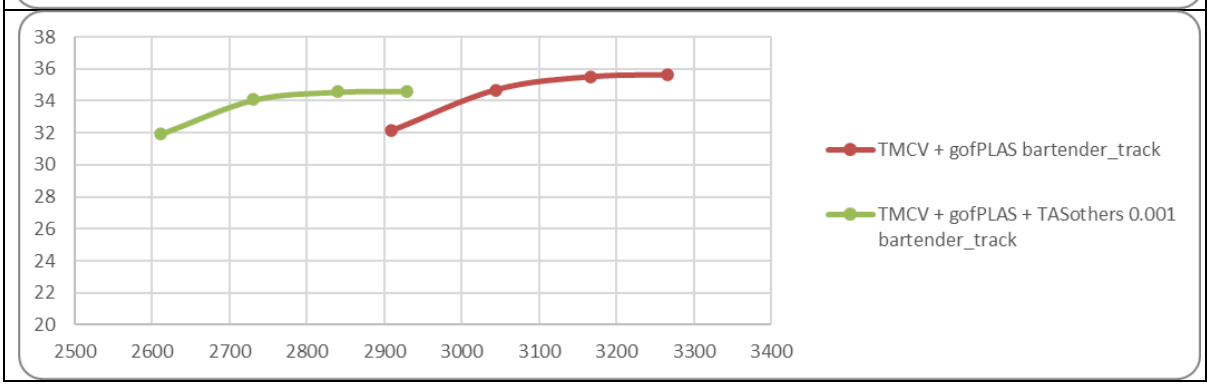
TMCV + gofPLAS bartender_semitrack
TMCV + gofPLAS + TASothers 0.001 bartender_semitrack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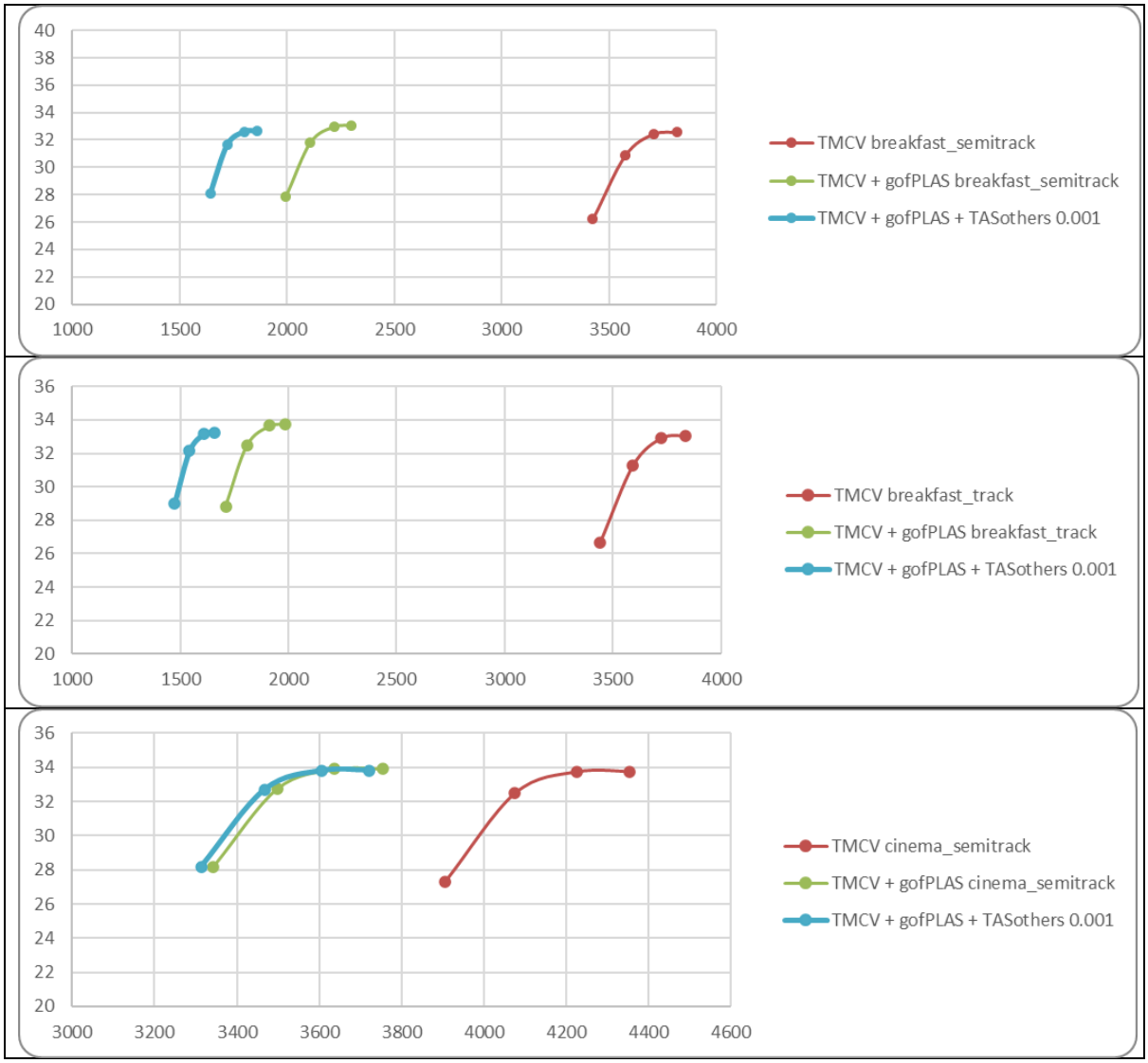
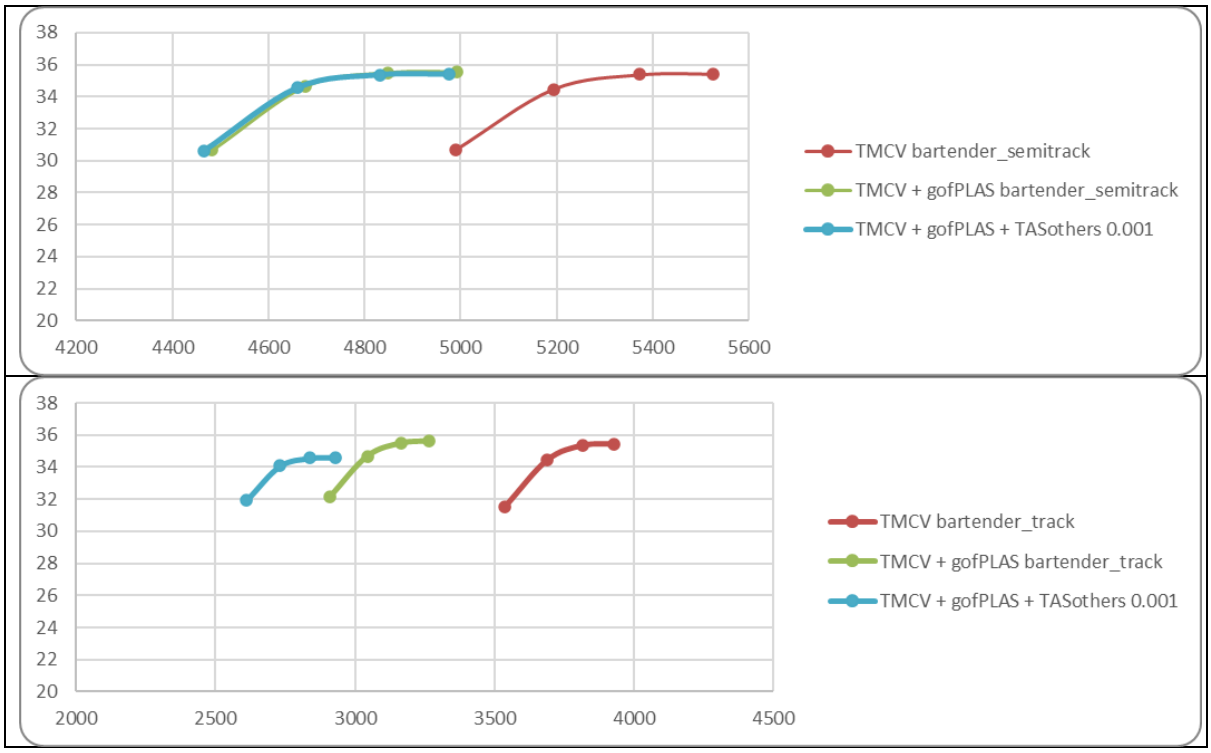
TMCV + gofPLAS bartender_track
TMCV + gofPLAS + TASothers 0.001 bartender_track

RGB-PSNR results:

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TMCV bartender_semitrack
TMCV + gofPLAS bartender_semitrack
TMCV + gofPLAS + TASothers 0.001
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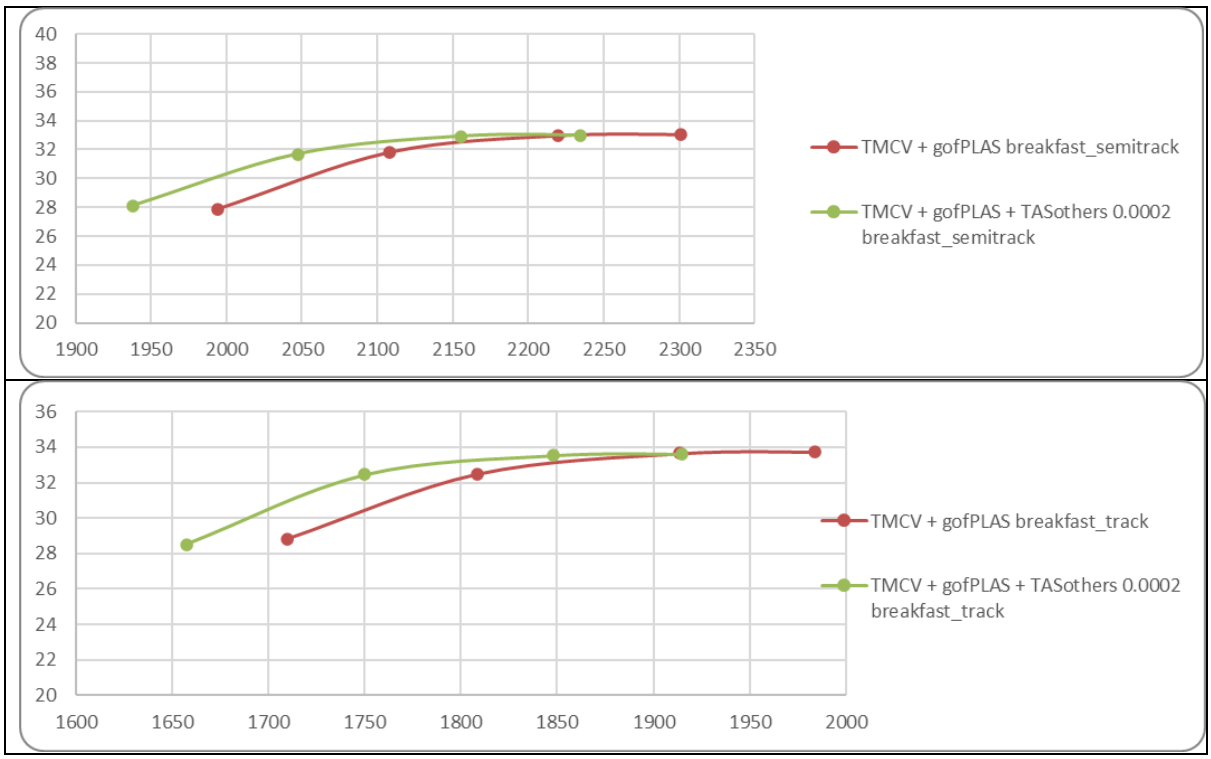
TMCV bartender_track
TMCV + gofPLAS bartender_track
TMCV + gofPLAS + TASothers 0.001

0.0002: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TMCV + gofPLAS breakfast_semitrack
TMCV + gofPLAS + TASothers 0.0002 breakfast_semitrack
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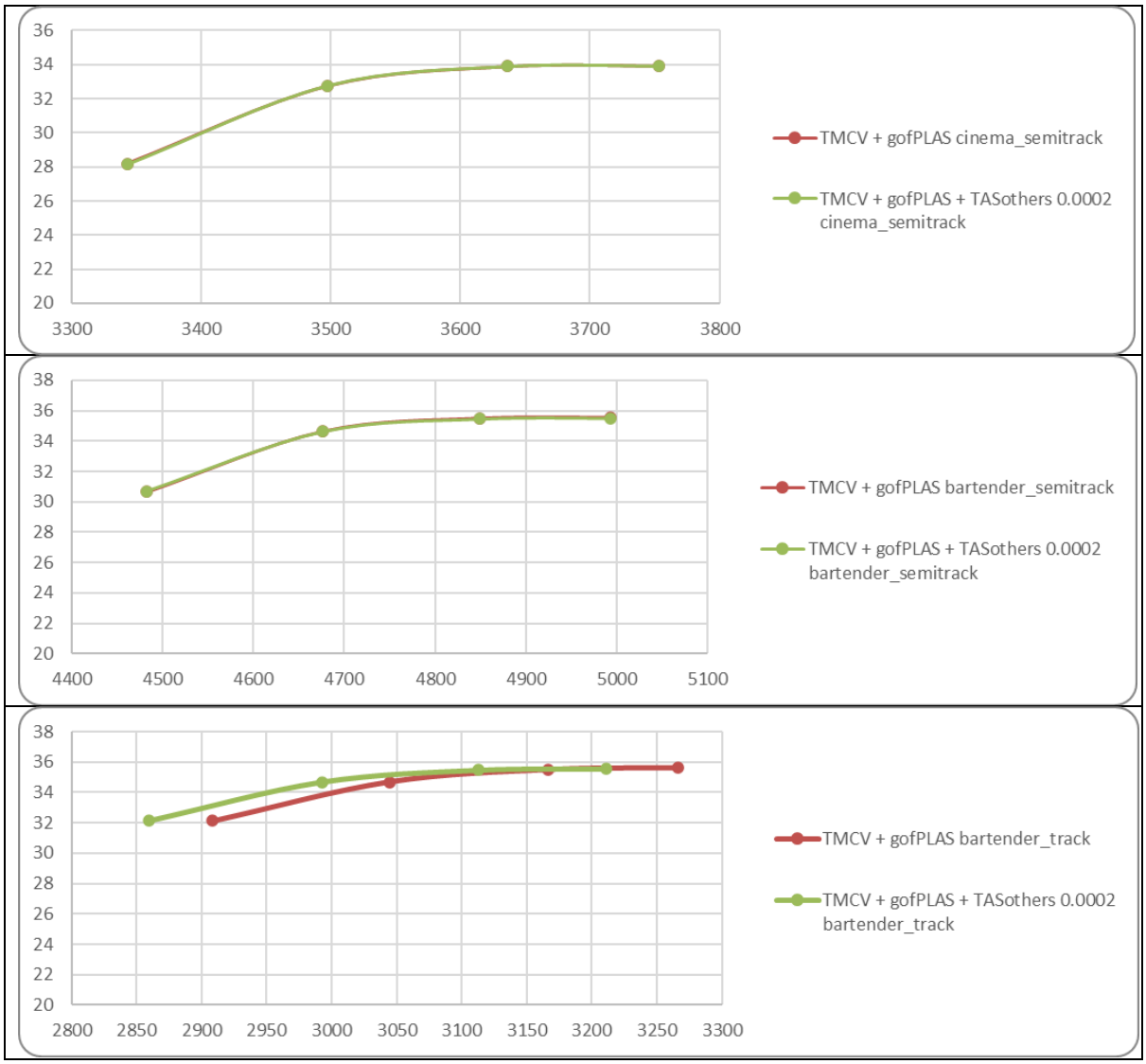
TMCV + gofPLAS breakfast_track
TMCV + gofPLAS + TASothers 0.0002 breakfast_track



Remarks:

- The proposed approach allows for significant decrease of the bitrate while preserving (for some sequences) objective quality
- When compared to the opacity smoothing approach, the decrease is significantly higher.
- Percentage of static splats differs when using different thresholds and tracked/partially-tracked sequences, e.g., Breakfast:

	Tracked	Partially-tracked
0.005	82%	80%
0.001	76%	73%
0.0002	34%	28%

4. Recommendations

No recommendations so far.

5. Acknowledgment

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